PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : B23D 57/00

A1

(11) International Publication Number: WO 99/00210

(43) International Publication Date: 7 January 1999 (07.01.99)

(21) International Application Number: PCT/EP98/03817

(22) International Filing Date: 23 June 1998 (23.06.98)

(30) Priority Data:
TO97U000128 26 June 1997 (26.06.97) IT

(71)(72) Applicants and Inventors: BROCCO, Emilio [IT/IT]; Via Alice, 40, I-10010 Lessolo (IT). CHIOLINO, Fabrizio [IT/IT]; Via Vittorio Veneto, 160, I-10010 Lessolo (IT). OBERTO TARENA, Felicino [IT/IT]; Via Arduino Casale, 37, I-10010 Lessolo (IT).

(74) Agent: APRA', Mario; Via Bertola, 2, I-10121 Torino (IT).

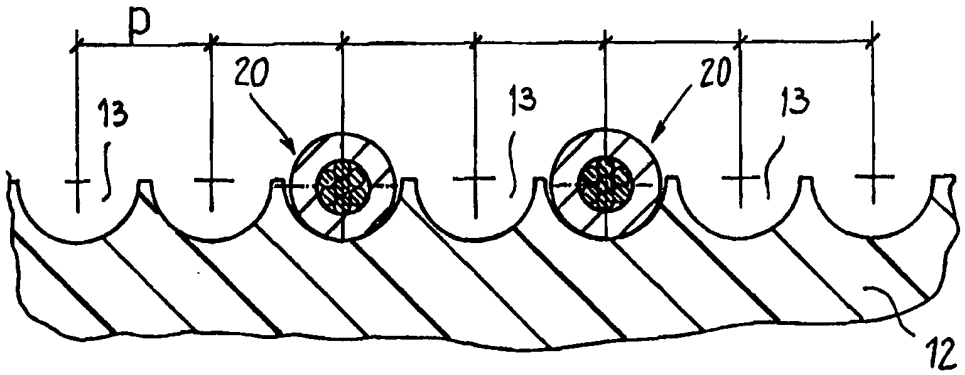
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published

With international search report.

Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: SAWING MACHINE FOR DIVIDING BLOCKS OF STONE MATERIAL INTO SLABS



(57) Abstract

In the sawing machine, "cutting wires" are each wound in a closed loop and run between a driving pulley and a driven pulley. The distance between adjacent cutting wires and, therefore, the thickness of the slabs cut by the said wires is defined. The sawing machine, according to the invention, includes a guide pulley (10) with a plurality of external circumferential grooves (13) which are separated from each other at a pitch or constant distance (p) that is approximately equal to a standard reference unit of measurement or fraction thereof for the thickness of the slabs that are to be cut. Each cutting wire (20) is guided in its own groove selected from among the said grooves (13) of the guide pulley (10), in such a way that the thickness(s) of the finished slab cut by two adjacent cutting wires (20) is approximately equal to the pitch (p) multiplied by the number (n-2) of unoccupied grooves (13) of the guide pulley (10) between the said two adjacent cutting wires (20) performing the cutting.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	**ES**	Spain	**LS**	Lesotho	**SI**	Slovenia
AM	Armenia	**FI**	Finland	**LT**	Lithuania	**SK**	Slovakia
AT	Austria	**FR**	France	**LU**	Luxembourg	**SN**	Senegal
AU	Australia	**GA**	Gabon	**LV**	Latvia	**SZ**	Swaziland
AZ	Azerbaijan	**GB**	United Kingdom	**MC**	Monaco	**TD**	Chad
BA	Bosnia and Herzegovina	**GE**	Georgia	**MD**	Republic of Moldova	**TG**	Togo
BB	Barbados	**GH**	Ghana	**MG**	Madagascar	**TJ**	Tajikistan
BE	Belgium	**GN**	Guinea	**MK**	The former Yugoslav Republic of Macedonia	**TM**	Turkmenistan
BF	Burkina Faso	**GR**	Greece			**TR**	Turkey
BG	Bulgaria	**HU**	Hungary	**ML**	Mali	**TT**	Trinidad and Tobago
BJ	Benin	**IE**	Ireland	**MN**	Mongolia	**UA**	Ukraine
BR	Brazil	**IL**	Israel	**MR**	Mauritania	**UG**	Uganda
BY	Belarus	**IS**	Iceland	**MW**	Malawi	**US**	United States of America
CA	Canada	**IT**	Italy	**MX**	Mexico	**UZ**	Uzbekistan
CF	Central African Republic	**JP**	Japan	**NE**	Niger	**VN**	Viet Nam
CG	Congo	**KE**	Kenya	**NL**	Netherlands	**YU**	Yugoslavia
CH	Switzerland	**KG**	Kyrgyzstan	**NO**	Norway	**ZW**	Zimbabwe
CI	Côte d'Ivoire	**KP**	Democratic People's Republic of Korea	**NZ**	New Zealand		
CM	Cameroon			**PL**	Poland		
CN	China	**KR**	Republic of Korea	**PT**	Portugal		
CU	Cuba	**KZ**	Kazakstan	**RO**	Romania		
CZ	Czech Republic	**LC**	Saint Lucia	**RU**	Russian Federation		
DE	Germany	**LI**	Liechtenstein	**SD**	Sudan		
DK	Denmark	**LK**	Sri Lanka	**SE**	Sweden		
EE	Estonia	**LR**	Liberia	**SG**	Singapore		

SAWING MACHINE FOR DIVIDING BLOCKS OF STONE MATERIAL INTO SLABS

This invention relates to a sawing machine for dividing blocks of stone material into slabs.

International application No. PCT/EP 97/00709 discloses a sawing machine for dividing blocks of stone material into slabs.

This sawing machine comprises a plurality of cutting tools each consisting of a metal cord member referred to for brevity in the rest of the text as a "cutting wire". The cutting wires are each wound in a closed loop and run between a driving pulley and a driven pulley and are maintained at a distance from each other by guide means which are distinct from the pulleys. Each cutting wire is disposed in its own e.g. vertical plane approximately parallel to the planes containing the adjacent cutting wires. The distance between adjacent cutting wires and, therefore, the thickness of the slabs cut by the said wires is therefore defined.

The driving pulley has a flat rim - in other words its outer peripheral circumference has a smooth surface.

In a sawing machine of this type the thickness of the slabs being cut often requires changing, in particular in accordance with predetermined measurements based on a standard reference unit of measurement, for example 1 cm = 10 mm.

The slab thickness considered here is that obtained on a finished slab, i.e. after removal from the cut slab of a superficial layer of material by grinding and/or polishing the slab. The thickness of this superficial layer of material may be, for instance, equal to one tenth of the said standard reference unit of measurement (i.e. approximately 1 mm).

Hence, for example, a block of stone material is cut, simultaneously or successively, either into slabs whose thickness is equal to the standard reference unit of measurement plus the thickness of the superficial layer to

be removed (10 mm + ≈ 1 mm), or into other slabs whose thickness is equal to a whole multiple of this standard reference unit of measurement plus the thickness of the superficial layer to be removed (20 mm + ≈ 1 mm; 30 mm + ≈ 1 mm, and so on).

Changing the thickness of the slabs to be cut is a complicated and laborious operation which may also require replacing parts of the sawing machine.

The primary object of the present invention is to provide a sawing machine, for dividing blocks of stone material into slabs, that will make it possible to simply and quickly change the thickness of the slabs to be cut and allow the cutting, simultaneously or otherwise, of slabs of different thicknesses which are defined in particular with reference to a standard reference unit of measurement.

Another object is to provide a sawing machine as specified that will be safe and reliable in use, of simplified structure and easy to maintain.

With a view to these objects, the present invention provides a sawing machine for dividing blocks of stone material into slabs, the essential feature of which forms the subject of the main claim.

Other advantageous features are described in the dependent claims.

The abovementioned claims should be regarded as incorporated here in their entirety.

The present invention is described in detail below, with reference to the attached non-restrictive drawings, in which:

- Fig. 1 shows, in axial section, an example of an embodiment of a guide pulley for the sawing machine according to the invention;

- Fig. 2 is a detail view, on a larger scale, of the detail marked II in Fig. 1;

- Fig. 3 is a side view on a larger scale of a length of cutting wire used with the pulley of Fig. 1;

- Fig. 4 is a section on IV-IV as marked in Fig. 3; and

- Figs 5 to 7 are schematic views, similar to Fig. 2 but on a larger scale, illustrating three different operating arrangements of two cutting wires, as shown in Figures 3 and 4, in combination with the pulley shown in Figure 1.

With reference to the drawings, 10 (Fig. 1) is a general reference for a guide pulley with which the sawing machine is provided for dividing blocks of stone material into slabs according to the present invention (the rest of the machine is not illustrated here, but its general structure is known from the abovementioned international application PCT/EP 97/00709).

The said pulley 10 comprises a wheel-like body 10.1, made of metal for example, on whose flat outer circumference 11 is fixed an external peripheral annular rim 12, made of an elastomeric material for example.

The said annular rim 12 contains a plurality of external circumferential grooves 13, which in Fig. 1 are indicated schematically only, while in Fig. 2 they are shown in greater detail.

In the present illustrative embodiment, the said annular rim 12 contains fifty-five circumferential grooves 13.

The said circumferential grooves 13 are situated in respective mid-planes which are normal to the axis of the pulley 10 and which are separated from each other at a pitch or constant distance p that is approximately equal to a standard reference unit of measurement for the thickness of the slabs that are to be cut, that is to say in the example illustrated equal to 1 cm = 10 mm.

Fig. 3 illustrates a length of cutting wire 20 which, when in use, is wound in an endless closed loop and run between a driving pulley and a driven pulley in the sawing machine according to the invention. As an example, either or both of the said driving pulley and driven pulley is produced as the pulley 10 described above and

each cutting wire 20 occupies its own groove 13 in this pulley.

The said cutting wire 20 comprises a steel cord 21 formed from a plurality of helically wound metal strands with abrasive bushes 22 external to and coaxial with the cord 21 fixed to it at equal intervals (Fig. 4). The said cord 21 is coated between the bushes 22 with a plastic sheath 23.

Using ϕ to denote the maximum diameter of the cutting wire 20, that is the external diameter of an abrasive bush 22, e.g. equal to 8.5 mm, and $\underline{w}$ to indicate the width of the groove cut in the block of stone material each time an abrasive bush 22 passes through it, it has been found experimentally that: $\underline{w} = \phi + \approx 1 \text{ mm} = \approx 9.5 \text{ mm}$, in view of the play of the cutting wire 20 with respect to its corresponding groove 13 in the guide pulley 10 around which the said cutting wire 20 is wound.

Given the above, for the cutting of each slab the following equation applies [1]:

$$s = n\,\underline{p} - 2\,\underline{w} - s'$$

in which:

s = thickness of finished slab,

n = number of grooves 13 between the two adjacent cutting wires 20 performing the cutting of the slab, including the grooves 13 occupied by the said adjacent wires 20, and

s' = layer of material of slab to be removed after cutting by grinding and/or polishing, for example ≈ 1 mm.

Thus, in the example shown, in which $\underline{p}$ = 10 mm, in order to cut a slab in which s = 1 cm (thickness of ground and polished slab), from equation [1]:

10 mm = n*10 mm - 2*9.5 mm - 1 mm, that is

$$10 = n*10 - 20,$$

it follows that n = 3,

in other words that, in order to cut a 1 cm-thick finished slab, two adjacent cutting wires 20 must each occupy an end groove 13 in an interval of three adjacent grooves 13 on the pulley 10, as illustrated in Fig. 5.

Similarly if a slab is to be cut in which s = 2 cm, from equation [1] it is found that:

$$20 \text{ mm} = n*10 \text{ mm} - 2*9.5 \text{ mm} - 1 \text{ mm}, \text{ that is to say}$$

$$20 = n*10 - 20,$$

and therefore n = 4.

In this case, in order to cut a 2 cm-thick finished slab, two adjacent cutting wires 20 must each occupy an end groove 13 in an interval of four adjacent grooves 13 on the pulley 10, as illustrated in Fig. 6.

Furthermore, if a slab is to be cut in which s = 3 cm, from equation [1] it follows that:

$$30 \text{ mm} = n*10 \text{ mm} - 2*9.5 \text{ mm} - 1 \text{ mm}, \text{ that is to say}$$

$$30 = n*10 - 20,$$

from which n = 5.

In other words, in order to cut a 3 cm-thick finished slab, two adjacent cutting wires 20 must each occupy an end groove 13 in an interval of five adjacent grooves 13 on the pulley 10, as in the arrangement illustrated in Fig. 7.

And so on.

To put it another way, we also have the following equation [2]:

$$s = (n - 2) * p,$$

meaning that the thickness (s) of the finished slab is approximately equal to the pitch (p) multiplied by the number (n - 2) of unoccupied grooves 13 on the pulley 10 between the two adjacent cutting wires 20 performing the cutting of the said slab.

If it is wished to cut a block which after grinding and/or polishing is to have a thickness of 3 cm (s = 30 mm), the operator simply arranges two adjacent cutting wires 20 on the pulley 10 as illustrated in Fig. 7, that is to say, leaving three unoccupied grooves 13 between two cutting wires 20, arranged in respective grooves 13 either side of the said three unoccupied grooves.

To cut a slab with a thickness of 2 cm (s = 20 mm) or 1 cm (s = 10 mm), two adjacent cutting wires 20 are arranged on the pulley 10 as illustrated in Fig. 6 or Fig. 5, respectively, i.e. leaving two unoccupied grooves 13 or a single unoccupied groove 13 between the said cutting wires 20, which occupy respective grooves 13 either side of the said two unoccupied grooves 13 or single unoccupied groove 13.

From equation [2] it follows that, given p = 6.35 mm, the equation

$$25.4 \text{ mm} = (n - 2) * 6.35 \text{ mm}$$

is satisfied for n = 6. That is 6.35 = ¼ 25.4.

Hence a guide pulley (not shown) provided with a plurality of (for example eighty-five) external circumferential grooves which are separated from each other at a constant pitch p = 6.35 mm, makes it possible to cut (in combination with cutting wires having a maximum external diameter ϕ = 6.0 mm approx.) finished slabs from blocks of stone material with a thickness s = 25.4 mm ≈ 1 inch, by arranging at intervals of six adjacent grooves on the pulley two cutting wires in order that each wire occupies its own groove at the end of the said interval.

In other words, four unoccupied grooves must be left between the pairs of adjacent cutting wires.

With this arrangement it is possible to cut finished slabs with a thickness defined according to the standard unit of measurement of 1 inch and whole multiples thereof.

As is clear from the foregoing, the operation of changing the thickness of the slabs to be cut can be carried out quickly and easily. The operator has simply to arrange the cutting wires 20 in the grooves 13 of the guide pulley 10, while his own intuition will prompt him to set, at the thickness selected for each slab to be cut, the number of grooves 13 to be left unoccupied between the adjacent cutting wires 20 performing the cutting of the slab.

The pulley 10 provides constant and precise guidance of the cutting wires 20 in their respective cutting planes during the cutting operation.

As a variant of the above, the guide pulley 10 may be separate from the driving pulley and/or from the driven pulley of the sawing machine according to the present invention.

CLAIMS

1. Sawing machine for dividing blocks of stone material into slabs, in which a plurality of cutting tools, consisting of individual metal cord members hereinbelow termed "cutting wires", are each wound in a closed loop and run between a driving pulley and a driven pulley, and in which each cutting wire is disposed in its own e.g. vertical plane approximately parallel to the planes containing the adjacent cutting wires, in such a way as to define the distance between adjacent cutting wires and, therefore, the thickness of the slabs cut by the said wires, which machine is characterized in that it includes a guide pulley (10) with a plurality of external circumferential grooves (13) in respective mid-planes, which may for example be normal to the axis of the said pulley and which are separated from each other at a pitch or constant distance (p) that is approximately equal to a standard reference unit of measurement or fraction thereof for the thickness of the slabs that are to be cut, and in that each cutting wire (20) is guided in its own groove selected from among the said grooves (13) of the guide pulley (10), in such a way that the thickness (s) of the finished slab cut by two adjacent cutting wires (20) is approximately equal to the pitch (p) multiplied by the number (n - 2) of unoccupied grooves (13) on the guide pulley (10) between the said two adjacent cutting wires (20) performing the cutting.

2. Sawing machine according to Claim 1, characterized in that the said guide pulley (10) also acts as a driving pulley and/or driven pulley of the sawing machine.

3. Sawing machine according to Claim 1, characterized in that the said guide pulley (10) is separate from the said driving pulley and the said driven pulley.

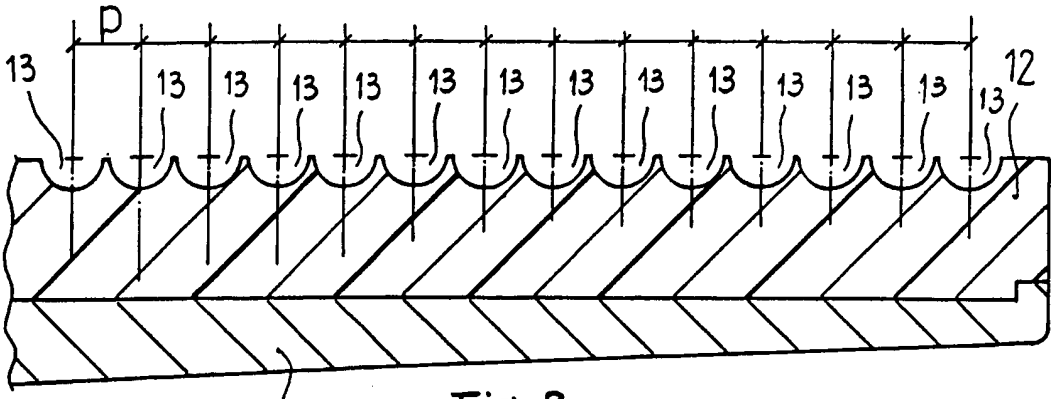


Fig. 2

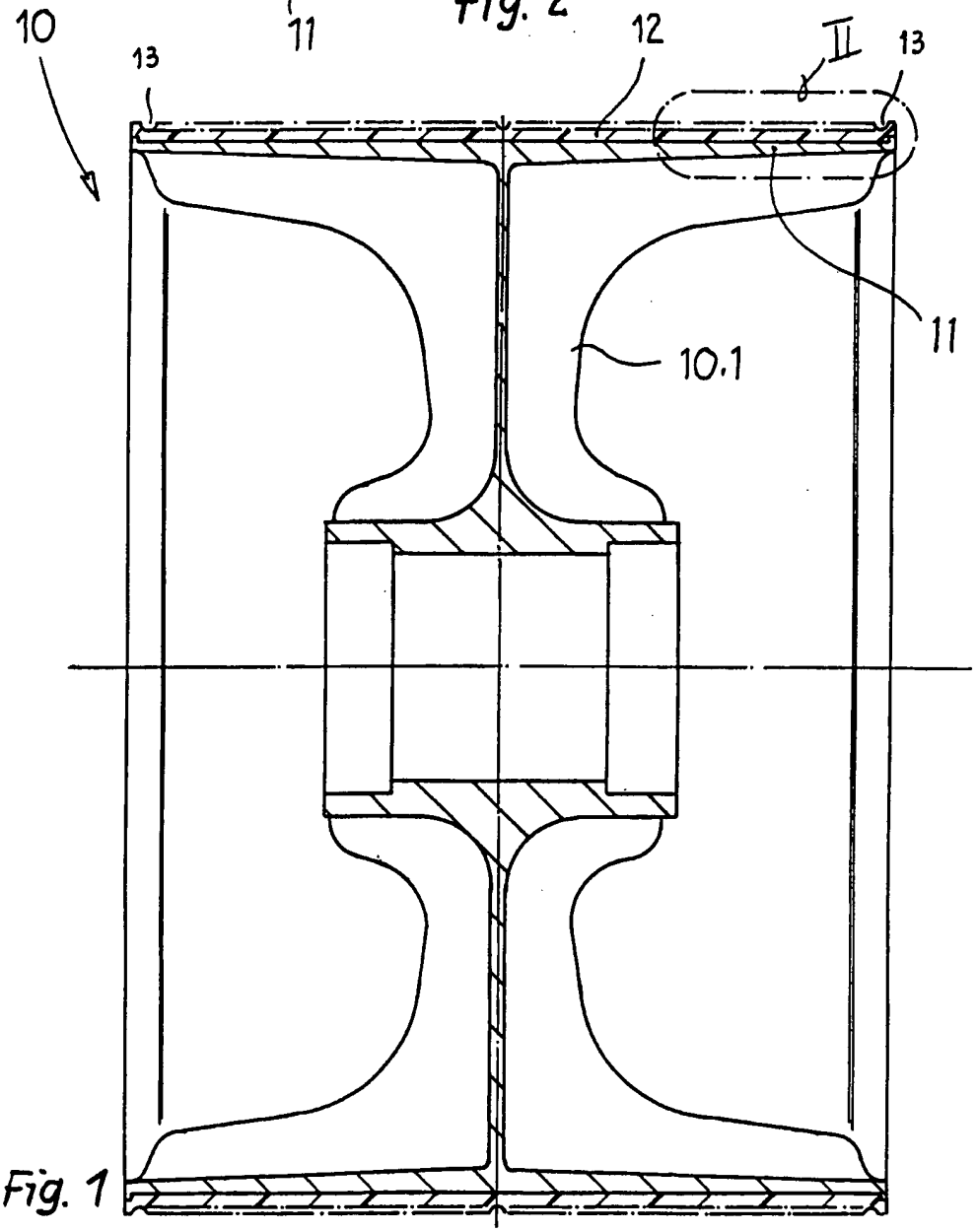


Fig. 1

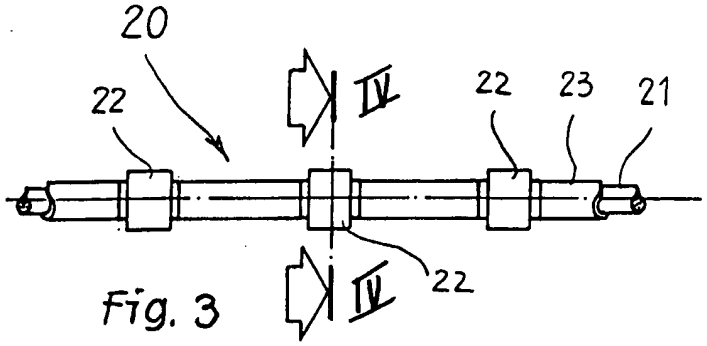


Fig. 3

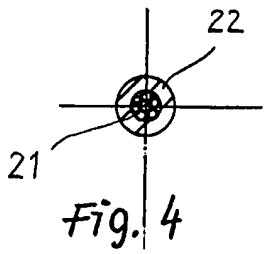


Fig. 4

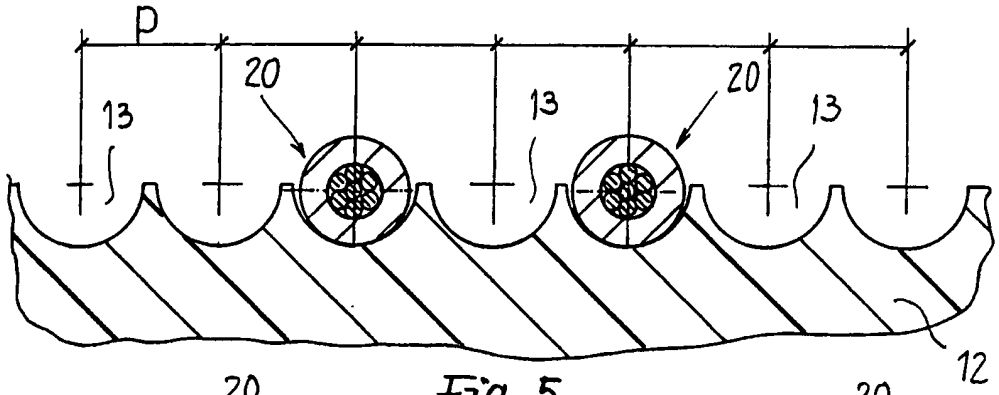


Fig. 5

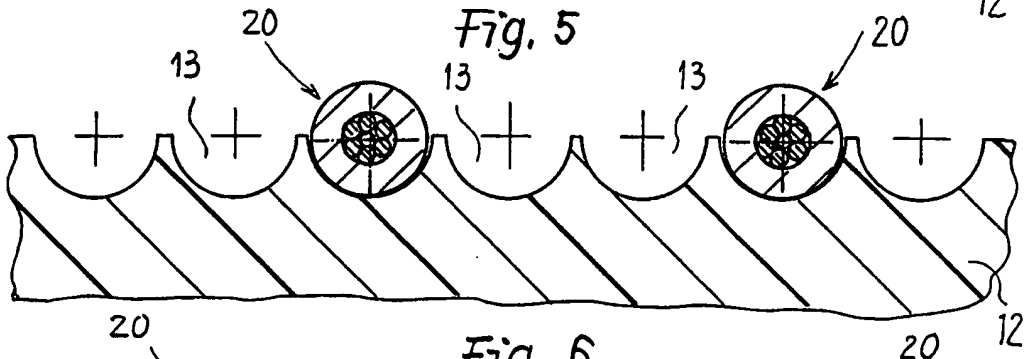


Fig. 6

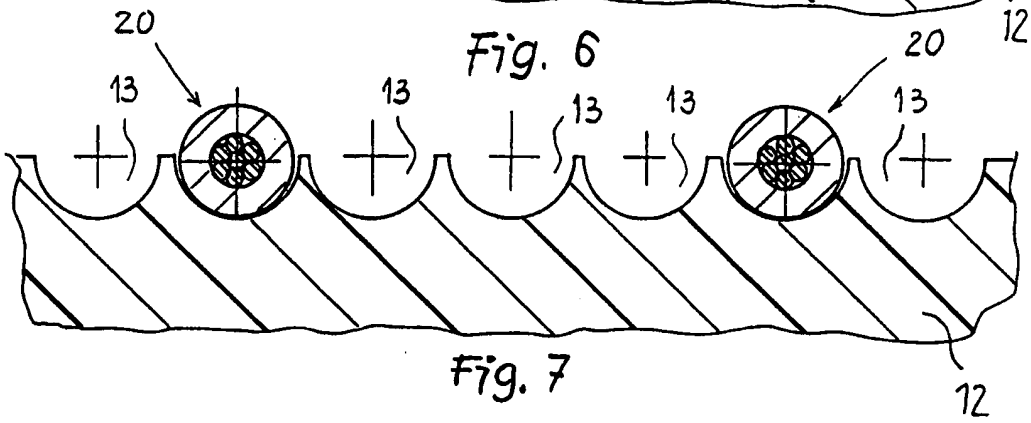


Fig. 7

INTERNATIONAL SEARCH REPORT

Inter Application No
PCT/EP 98/03817

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B23D57/00

According to International Patent Classification(IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B23D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2 958 323 A (N.L.KNOPH ET AL) 1 November 1960 see column 2, line 33 - line 44 see column 3, line 20 - line 23 see column 5, line 1 - line 43 see column 5, line 69 - column 6, line 2; figures	1-3

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 October 1998	29/10/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Moet, H

1

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter Application No
PCT/EP 98/03817

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2958323 A	01-11-1960	NONE	